CLASSIFICATION CONFIDENTIAL CONFIDENTIAL

CENTRAL INTELLIGENCE AGENCY
INFORMATION FROM
FOREIGN DOCUMENTS OR RADIO BROADCASTS

REPORT

CD NO.

COUNTRY USSR

DATE OF INFORMATION 1949

SUBJECT Nuclear physics - Beta spectrometers

HOW PUBLISHED Thrice-monthly periodical

DATE DIST. 12 Dec 1949

WHERE PUBLISHED Moscow

NO. OF PAGES 3

DATE PUBLISHED 11 Sep 1949

SUPPLEMENT TO REPORT NO

LANGUAGE Russian

SOURCE Doklady Akademii Nauk SSSR, Vol LXVIII, No 2, 1949

MEASURING THE PARTIAL BETA-SPECTRUM OF TAB BY THE METHOD OF COINCIDENCES WITH THE AID OF A DOUBLE BETA-SPECTROMETER

L. V. Groshev
L. Ya. Shavtvalov
Moscow State U imeni M. V. Lomonosov

The atomic nuclei which emerge as a result of beta-decay are usually found in excited states, which are made known by the fact that beta-decay is accompanied by the emission of gamma-rays. In those cases where decay leads to the formation of an end nucleus in several different energy states, we obtain a complex beta-spectrum, which is the result of the superposition of a number of elementary, partial beta-spectra corresponding to transitions to different nuclear levels of the product. To solve the problem of the form of the beta-spectrum, the complex spectrum must be broken down into the elementary spectra. Such an analysis is also interesting from the standpoint of establishing the system of nuclear energy levels of the product. The elementary spectra are frequently separated by resolving the proper Fermi graph into separate linear sections. This method, however, is not particularly reliable or accurate. Therefor it would be desirable to measure the elementary beta-spectra directly.

If, as a result of beta-decay, the end nucleus is formed in the ground state and in one of the excited states, separation of the partial spectra may be accomplished easily by using the method of beta-gamma coincidences. The number of beta-gamma coincidences is measured for various energy sections of the continuous beta-spectrum, separated by some sort of beta-spectrometer. Such measurements immediately yield the partial beta-spectrum corresponding to the transition to the excited nuclear level of the product.

The problem becomes considerably more complex when the end nucleus forms in several excited states. In this case, the beta-gamma coincidences belonging to photons of definite energy which are emitted in the radiation of the given excited state must be distinguished.

This can be done if, instead of a gamma-counter, a second beta-spectrometer is used to separate the conversion (or other secondary) electrons from the corresponding gamma-line. Given such an apparatus, the partial beta-spectrum may be resolved by measuring the number of beta-beta coincidences for a fixed conversion line and for different sections of the continuous spectrum.

With this purpose in mind, we constructed a double beta-spectrometer. (Figure 1, appended). It is a combination of two identical beta-spectrometers with magnetic lenses. A copper pipe with a diameter of 18.4 centimeters and an over-all length of 2 meters was used as a vacuum chamber T. The inside of the pipe was lined with a 3-millimeter aluminum layer. The beta-counters C_1 and C_2 were placed endwise at both ends of the pipe. The magnetic lenses L_1 and L_2 were aligned separately with the aid of a special device which aligned the axis of each lens with the axis of the pipe. A current coil, placed in the horizontal plane passing through the axis of the pipe, was used to compensate for the vertical component of the earth's magnetic field. The source S was placed in the center point of the pipe. It could be replaced without disturbing the vacuum through the use of a special locking unit LU.

The coincidences in counters C_1 and C_2 were registered by an electronic circuit with a resolving power of 3×10^{-7} second.

The double beta-spectrometer was used to study the beta-spectrum of an active thorium deposit, precipitated on a thin aluminum foil in the form of a small circle 8 millimeters in diameter.

The spectrum of a thorium deposit is the superposition of the beta-spectra of three radioactive elements: ThB, ThC'', and ThC, whose upper limits are, respectively, equal to 340, 1,820, and 2,250 keV. In transitions ThB→ThC, the majority of the decays occurs at the excited nuclear level of ThC with an excitation energy of 238 keV. The gamma-rays emitted in radiation of this state are very active in conversion in the electron shell, yielding an intense line H = 1,385 oersteds per centimeter, corresponding to the extraction of an electron from the K-level. We used this conversion line to separate the fundamental partial beta-spectrum of ThB from the complex spectrum of the thorium deposit.

In the measurements, the conversion electrons of H = 1,385 oersteds per centimeter were focused on the counter C_1 by the magnetic lens L_1. The current in the other magnetic lens L_2 was varied so that electrons of different energies of the complex beta-spectrum for the thorium deposit fell alternately upon the counter C_2.

A beta-spectrum was obtained. The curve was corrected for absorption of electrons in the window of the counter. The comparatively small statistical accuracy of separate measurements is due to the fact that a weak preparation was used (approximately 25 micro Curies). Stronger sources could not be used because the number of chance coincidences increases proportionally to the square of source activity, while the number of genuine coincidences increases linearly. The following numbers represent the relation between chance and genuine coincidences for the region close to the spectrum maximum: N_c = 0.51 pulse per minute and N_g = 0.73 pulse per minute.

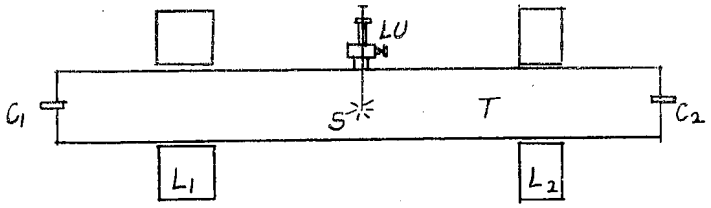
The ThB spectrum is presented in the form of a Fermi graph, which is rectilinear throughout, from its upper limit down to 80 keV. Thus, the elementary character of the beta-spectrum under consideration is confirmed. By extrapolating the curve to the abscissa, we obtain 340 keV as the upper limit of the beta-spectrum. This figure agrees well with other data.

50X1-HUM

The complete spectrum for the active thorium deposit was obtained with the aid of the second beta-spectrometer. Its upper limit lies at approximately 2,250 keV. The spectrum of beta-beta coincidences for ThB was also reproduced for comparison. Allowance was made for absorption in the windows of the counters in both cases. In these graphs the number of electrons of the spectra of ThB and Th(B+C+C'') in arbitrary (and different for both curves) dimensions is placed along the abscissa.

While this work was being completed, an article by N. Feather, J. Kyles, and R. W. Pringle (Proc. Phys. Soc., 61, 466, 1948) appeared, describing the results of similar measurements with an active thorium deposit. Unlike our work, however, their measurements were conducted in a unit consisting of two Denish-type beta-spectrometers. Therefore, to resolve the different sections of the continuous beta-spectrum, they had to resort to the shifting of Geiger counters, thus complicating the work.

[Appended figure follows.]



50X1-HUM

Figure 1

- E N D -